PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

TSUIDA, Shunji, et al.

(Divisional of U.S. Serial 09/808/041 — Group Art Unit: Unknown

Confirmation No.: Unknown — Examiner: Unknown

Div. Filed: September 24, 2001

For: ELECTRON TUBE DEVICE MOUNTED WITH A COLD CATHODE AND A METHOD OF IMPRESSING VOLTAGES ON ELECTRODES OF THE ELECTRON TUBE DEVICE

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE SPECIFICATION:

Amend the specification by inserting before the first line the sentence:

--This is a divisional of Application No. 09/808,041 (Confirmation No. Unknown) filed March 15, 2001, which is a Divisional Application of 09/132,571 now allowed filed August 12, 1998 the disclosure of which is incorporated herein by reference.--

Please make the changes to the specification as noted below. To aid the Examiner in the identification of the changes, a marked-up version of the specification changes is attached as an addendum hereto.

In the last paragraph of page 4 (which bridges over to page 5), please delete that paragraph and replace it with the following paragraph:

Fig. 2 shows an example of a structure of the traveling wave tube disclosed in Japanese Patent Laid-open No. 192638/95. A traveling wave tube is an electron tube which amplifies a microwave by utilizing the interaction between the electron beam (e) and the microwave, and has slow wave circuit 2 which makes the electron beam and the microwave interact between an electron gun and a collector electrode (not shown). The electron gun includes cathode 10, Wehnelt electrode 12, accelerating electrode 13 and ion barrier electrode 16. If a beam current is denoted as Io (A), a beam radius ro (m), the inside diameter of ion barrier electrode 16 rib (m), electric potential of slow wave circuit 2 Vo (V), the inside diameter rib and the electric potential Vib of ion barrier electrode 16 are determined so that they can satisfy the following relationship.

$$\mathrm{Vo} < \mathrm{Vib} - \frac{\alpha I0}{\sqrt{Vib}}\left[2\log\frac{rib}{ro}+1\right]$$

$$\alpha = 1.515 \times 10^{4} \ (V^{3/2}/A)$$

In the first full paragraph of page 5, please delete that paragraph and replace it with the following paragraph:

According to the present invention, the ion barrier electrode can prevent ions from reaching the cathode by always forming a surface of high electric potential which can prevent the generation of positive ions to caused in a slow wave circuit or the collector electrode side, that is,

a barrier. The patent has no description with reference to a cold cathode, but it is also applicable to a traveling wave tube mounted with a cold cathode.

In the first full paragraph of page 27, please delete that paragraph and replace it with the following paragraph:

A method of impressing voltages on electrodes of this electron tube device mounted with the cold cathode comprises, as shown in Fig. 3, the steps of:

In last paragraph of page 27 (which bridges over to page 28), please delete that paragraph and replace it with the following paragraph:

In the electron tube device mounted with the cold cathode, as shown in figure 12, by impressing an appropriate voltage on gate electrode 24, electrons corresponding to electric currents determined by the voltage of gate electrode 24 are emitted from cold cathode 11, electrons are accelerated by accelerating electrode 13, and radiated to collector electrode 15 which has been impressed with voltage 41. At this time when the beam current is emitted from cold cathode 11 exceeding a product of a perveance of the electron gun and the 3/2 power of the impressed voltage, the beam is made to diverge strongly by the space charge effect thereby colliding with accelerating electrode 13. Consequently, gas leaves accelerating electrode 13, and then the gas and the beam collide with each other to produce positive ions. The positive ions are also directly generated from accelerating electrode 13. The positive ions generated between the cold cathode and the accelerating electrode proceed toward the cold cathode of low electric potential. Collision of positive ions against cold cathode 11 causes deterioration of the cold

cathode. However, in the present embodiment, since the beam current is less than the product of the perveance of the electron gun and the 3/2 power of the accelerating electrode voltage, the divergence of the beam is controllable even when the beam is made to diverge by the space charge effect and the beam scarcely collides with accelerating electrode 13. Accordingly, positive ions are scarcely generated between the cold cathode and the accelerating electrode and hence no deterioration of the characteristic of the cold cathode is observed.

In the first paragraph of page 30, please delete that paragraph and replace it with the following paragraph:

In the present embodiment, as shown, for example, in figure 13, since the voltage which satisfies expression 1 is impressed on accelerating electrode 13, electrons emitted from cold cathode 11 reach collector electrode 15 through the inside of helix 20 of slow wave circuit 2 without striking accelerating electrode 13 and ion trap electrode 14. Since electrons do not strike accelerating electrode 13, ion trap electrode 14 and helix 20, no impact damage is caused by positive ions on cold cathode 11 thereby allowing it to perform stable operation.

In the last paragraph of page 38 (which bridges over to page 39), please delete that paragraph and replace it with the following paragraph:

In the electron tube mounted with the cold cathode, slow wave circuit 2 is disposed between electron gun 1 and collector 15. By impressing voltages in a range of several tens V to a hundred and several tens V by power supply 42 on gate electrode 24, the beam current is

controlled, and by impressing voltage on Wehnelt electrode 12 so that the electric potential thereof becomes equivalent to that of the gate electrode or becomes lower than that of the gate electrode but higher than that of the emitter, the divergence of the beam is controlled. On helix 20 of slow wave circuit 2, a voltage of several kV is impressed by power supply 41, and on collector 15 a voltage equivalent to that of helix 20 is impressed by power supply 41 or a voltage negative to that of the helix is impressed by power supply 45. In order to acquire positive ions proceeding toward electron gun 1 from helix 20, a voltage lower than voltages of the helix and the collector electrode are impressed on ion trap electrode 14 by power supply 44, and a voltage which satisfies expression 1 is impressed on accelerating electrode 13 by power supply 43.

In the last paragraph of page 39 (which bridges over to page 40), please delete that paragraph and replace it with the following paragraph:

This electron tube mounted with the cold cathode is also a traveling wave tube. In the same way as the case of Fig. 13, on helix 20 of slow wave circuit 2, a voltage of several kV is impressed by power supply 41, and on collector 15 a voltage equivalent to that of helix 20 is impressed by power supply 41 or a voltage negative to that of the helix is impressed by power supply 45. In order to acquire positive ions proceeding toward electron gun 1 from helix 20, a voltage lower than voltages of the helix and the collector electrode are impressed on ion trap electrode 14 by power supply 44, and a voltage which satisfies expression 1 is impressed on accelerating electrode 13 by power supply 43. Since a voltage which satisfies expression 1 is impressed on acclerating electrode 13 by power supply 43, cold cathode 11 is arranged so that no

impulse damage will be caused by positive ions thereon. Further, it is necessary to control the time elapsed change of the emission currents emitted from cold cathode 11 for securing the stable operation of the traveling wave tube. Control of the emission current is realized by voltage control of gate electrode 24. When the Wehnelt voltage is kept constant and the gate voltage is varied, there is a possibility of having electrons which may strike accelerating electrode 13.

In the last paragraph of page 40 (which bridges over to page 41), please delete that paragraph and replace it with the following paragraph:

This embodiment also shows, in figure 15, for example, a traveling wave tube mounted with a cold cathode, and it differs from the electron tube device of Fig. 13 in that power supply unit 47 is employed in place of power supply 43. Power supply 47 impresses voltage on accelerating electrode 13 so that a positive voltage is impressed against helix 20 which serves as a reference. Cold cathode 11, ion trap electrode 14, collector electrode 15 receive voltages from power supply 41, 44 and 45 respectively, the voltages being negative against helix 20 which is used as the reference. Impressing voltage on gate electrode 24 by power supply 42 is arranged such that a voltage is finally impressed at the operation rise time of the electron tube and first cut at the fall time or at the time of emergency stop thereof.

In the first full paragraph of page 41, please delete that paragraph and replace it with the following paragraph:

A voltage drop time constant at the rise time of power supply unit 47 is larger when compared to those of power supply 41, 44 and 45. As shown in Fig. 16, a structure of power supply unit 47 can be realized by DC source 48 and capacitor 49, connected in parallel, DC source 48 having a voltage drop time constant equivalent to those of power supply 41, 44 and 45. Or, as shown in Fig. 17, the structure of power supply unit 47 can be realized by constructing it with DC source 48 and coil 50 connected in series to the anode side of DC source 48 which has a voltage drop time constant equivalent to those of power supply 41, 44 and 45. Further, power supply unit 47 can be constituted by using both capacitor 49 of Fig. 16, and coil 50 of Fig. 17, in combination with DC source 48. By using power supply unit 47, the electric potential of accelerating electrode 13 can be maintained at the highest level compared to those of other electrodes at the rise time and the time of emergency stop of the unit.

In the second paragraph of page 43, please delete that paragraph and replace it with the following paragraph:

The electron tubes in Figs, 13 to 15 are provided with the ion trap electrode. However, the electron tube of this embodiment is a cathode ray tube (hereinafter referred to as CRT) illustrated as an example of an electron tube which is not provided with an ion trap electrode. In Fig 18, an outside casing and CRT structure members other than the electron gun are omitted, and in Fig. 19, support structures of grids 26, 27, 28 and 29 are omitted.

In the third paragraph of page 43, please delete that paragraph and replace it with the following paragraph:

In the CRT of the present embodiment, as shown in Fig. 18, electron beam current Ib (not shown) emitted from cold cathode 11 (not shown) provided in electron gun 3 is adjusted by changing the voltage applied on gate electrode 24 (not shown). As shown in Fig. 19, a first grid 26 serves as an accelerating electrode in other embodiments, and electron beam e is accelerated and focused by passing through first grid 26, second grid 27, third grid 28 and fourth grid 29 to be emitted in the direction of fluorescent screen 17, as shown in Fig. 18.

In the last paragraph of page 43 (which bridges over to page 44), please delete that paragraph and replace it with the following paragraph:

When the voltage of first grid 26 is expressed as Va, electron gun perveance Pμ which is determined by the form of the electron gun and beam current Ib are settled so that they can satisfy expression 1.

IN THE CLAIMS

Cancel claims: 1-7, 9-16, and 19-24.

REMARKS

The amendments to the specification correspond to those made and approved in parent application serial number 09/132,571 and 09/808,041.

Entry and consideration of this Preliminary Amendment is respectfully requested.

Respectfully submitted,

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APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

Amend the specification by inserting before the first line the sentence:

--This is a divisional of Application No. 09/808,041 (Confirmation No. Unknown) filed March 15, 2001, which is a Divisional Application of 09/132,571 now allowed filed August 12, 1998 the disclosure of which is incorporated herein by reference.--

Changes to the last paragraph of page 4 (which bridges over to page 5):

Fig. 2 shows an example of a structure of the traveling wave tube disclosed in Japanese Patent Laid-open No. 192638/95. A traveling wave tube is an electron tube which amplifies a microwave by utilizing the interaction between the electron beam (e) and the microwave, and has slow wave circuit 2 which makes the electron beam and the microwave interact between an electron gun and a collector electrode (not shown). The electron gun includes cathode 10, Wehnelt electrode 12, accelerating electrode 13 and ion barrier electrode 16. If a beam current is denoted as Io (A), a beam radius ro (m), the inside diameter of ion barrier electrode 16 rib (m), electric potential of slow wave circuit 2 Vo (V), the inside diameter rib and the electric potential Vib of ion barrier electrode 16 are determined so that they can satisfy the following relationship.

$$Vo < Vib - \frac{aI0}{\sqrt{Vib}}\left[2\log\frac{rib}{ro}+1\right]$$

$$\alpha = 1.515 \text{ X } 10^{4} \ (V^{3/2}/A)$$

Changes to the first full paragraph of page 5:

According to the present invention, the ion barrier electrode can prevent ions from reaching the cathode by always forming a surface of high electric potential which can prevent the generation of positive ions to caused in a slow wave circuit or the collector electrode side, that is, a barrier. [Said] The patent has no description with reference to a cold cathode, but it is also applicable to a traveling wave tube mounted with a cold cathode.

Changes to the first full paragraph of page 27:

A method of impressing voltages on electrodes of this electron tube device mounted with the cold cathode comprises, as shown in Fig. [13] 3, the steps of:

Changes to the last paragraph of page 27 (which bridges over to page 28):

In the electron tube device mounted with the cold cathode, as shown in figure 12, by impressing an appropriate voltage on gate electrode 24, electrons corresponding to electric currents determined by the voltage of gate electrode 24 are emitted from cold cathode 11, electrons are accelerated by accelerating electrode 13, and radiated to collector electrode 15

which has been impressed with voltage 41. At this time when the beam current is emitted from cold cathode 11 exceeding a product of a perveance of the electron gun and the 3/2 power of the impressed voltage, the beam is made to diverge strongly by the space charge effect thereby colliding with accelerating electrode 13. Consequently, gas leaves accelerating electrode 13, and then the gas and the beam collide with each other to produce positive ions. The positive ions are also directly generated from accelerating electrode 13. The positive ions generated between the cold cathode and the accelerating electrode proceed toward the cold cathode of low electric potential. Collision of positive ions against cold cathode 11 causes deterioration of the cold cathode. However, in the present embodiment, since the beam current is less than the product of the perveance of the electron gun and the 3/2 power of the accelerating electrode voltage, the divergence of the beam is controllable even when the beam is made to diverge by the space charge effect and the beam scarcely collides with accelerating electrode 13. Accordingly, positive ions are scarcely generated between the cold cathode and the accelerating electrode and hence no deterioration of the characteristic of the cold cathode is observed.

Changes to the first paragraph of page 30:

In the present embodiment, <u>as shown, for example, in figure 13,</u> since the voltage which satisfies expression 1 is impressed on accelerating electrode 13, electrons emitted from cold cathode 11 reach collector electrode 15 through the inside of helix 20 of slow wave circuit 2 without striking accelerating electrode 13 and ion trap electrode 14. Since electrons do not strike

accelerating electrode 13, ion trap electrode 14 and helix 20, no impact damage is caused by positive ions on cold cathode 11 thereby allowing it to perform stable operation.

Changes to the last paragraph of page 38 (which bridges over to page 39):

In the electron tube mounted with the cold cathode, slow wave circuit 2 is disposed between electron gun 1 and collector 15. By impressing voltages in a range of several tens V to a hundred and several tens V by power supply 42 on gate electrode 24, the beam current is controlled, and by impressing voltage on Wehnelt electrode 12 so that the electric potential thereof becomes equivalent to that of the gate electrode or becomes lower than that of the gate electrode but higher than that of the emitter, the divergence of the beam is controlled. On helix 20 of slow wave circuit 2, a voltage of several kV is impressed by power supply 41, and on collector 15 a voltage equivalent to that of helix 20 is impressed by power supply 41 or a voltage negative to that of the helix is impressed by power supply 45. In order to acquire positive ions proceeding toward electron gun 1 from helix 20, a voltage lower than voltages of the helix and the collector electrode are impressed on ion trap electrode 14 by power supply [41] 44, and a voltage which satisfies expression 1 is impressed on accelerating electrode 13 by power supply 43.

Changes to the last paragraph of page 39 (which bridges over to page 40):

[The electron tube device mounted with the cold cathode of the present embodiment is also a traveling wave tube, and in the same way as the case of Fig. 13, since] This electron tube

mounted with the cold cathode is also a traveling wave tube. In the same way as the case of Fig. 13, on helix 20 of slow wave circuit 2, a voltage of several kV is impressed by power supply 41, and on collector 15 a voltage equivalent to that of helix 20 is impressed by power supply 41 or a voltage negative to that of the helix is impressed by power supply 45. In order to acquire positive ions proceeding toward electron gun 1 from helix 20, a voltage lower than voltages of the helix and the collector electrode are impressed on ion trap electrode 14 by power supply 44, and a voltage which satisfies expression 1 is impressed on accelerating electrode 13 by power supply 43. Since a voltage which satisfies expression 1 is impressed on acclerating electrode 13 by power supply 43, cold cathode 11 is arranged so that no impulse damage will be caused by positive ions thereon. Further, it is necessary to control the time elapsed change of the emission currents emitted from cold cathode 11 for securing the stable operation of the traveling wave tube. Control of the emission current is realized by voltage control of gate electrode 24. When the Wehnelt voltage is kept constant and the gate voltage is varied, there is a possibility of having electrons which may strike accelerating electrode 13.

Changes to the last paragraph of page 40 (which bridges over to page 41):

This embodiment also shows, in figure 15, for example, a traveling wave tube mounted with a cold cathode, and it differs from the electron tube device of Fig. 13 in that power supply unit 47 is employed in place of power supply 43. Power supply 47 impresses voltage on accelerating electrode 13 so that a positive voltage is impressed against helix 20 which serves as a reference. Cold cathode 11, ion trap electrode 14, collector electrode 15 receive voltages from

power supply 41, 44 and 45 respectively, the voltages being negative against helix 20 which is used as the reference. Impressing voltage on gate electrode 24 by power supply 42 is arranged such that a voltage is finally impressed at the operation rise time of the electron tube and first cut at the fall time or at the time of emergency stop thereof.

Changes to the first full paragraph of page 41:

A voltage drop time constant at the rise time of power supply unit 47 is larger when compared to those of power supply 41, 44 and 45. As shown in Fig. 16, a structure of power supply unit 47 can be realized by DC source 48 and capacitor 49 [parallelly connected thereto], connected in parallel, DC source 48 having a voltage drop time constant equivalent to those of power supply 41, 44 and 45. Or, as shown in [Fig, 17] Fig. 17, the structure of power supply unit 47 can be realized by constructing it with DC source 48 and coil 50 connected in series to the anode side of DC source 48 which has a voltage drop time constant equivalent to those of power supply 41, 44 and 45. Further, power supply unit 47 can be constituted by using both capacitor 49 of Fig. 16, and coil 50 of Fig. 17, in combination with DC source 48. By using power supply unit 47, the electric potential of accelerating electrode 13 can be maintained at the highest level compared to those of other electrodes at the rise time and the time of emergency stop of the unit.

Changes to the second paragraph of page 43:

The electron tubes in Figs, 13 to 15 are provided with the ion trap electrode. However, the electron tube of this embodiment is a cathode ray tube (hereinafter referred to as CRT) illustrated as an example of an electron tube which is not provided with an ion trap electrode. In Fig 18, an outside casing and CRT structure members other than the electron gun are omitted, and in Fig. 19, support structures of grids [26 - 29] 26, 27, 28 and 29 are omitted.

Changes to the third paragraph of page 43:

In the CRT of the present embodiment, as shown in Fig. 18, electron beam current Ib (not shown) emitted from cold cathode 11 (not shown) provided in electron gun 3 is adjusted by changing the voltage applied on gate electrode 24 (not shown). [A] As shown in Fig. 19, a first grid 26 serves as an accelerating electrode in other embodiments, and electron beam e is accelerated and focused by passing through first grid 26, second grid 27, third grid 28 and fourth grid 29 to be emitted in the direction of fluorescent screen 17, as shown in Fig. 18.

Changes to the last paragraph of page 43 (which bridges over to page 44):

[Here, when] When the voltage of first grid 26 is expressed as Va, electron gun perveance Pμ which is determined by the form of the electron gun and beam current Ib are settled so that they can satisfy expression 1.

IN THE CLAIMS

Cancel claims: 1-7, 9-16, and 19-24.